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August 2000

Equipment and Processes for Removing Debris and Trash from Dredged Material

PURPOSE: This technical note describes the types, features, and logistics of equipment that can be deployed to remove debris and trash from dredged material. It is one of a series of technical notes on alternative methods to extend the life of confined disposal facilities (CDFs) by removing dredged material or redirecting it to beneficial uses.

BACKGROUND: Debris removal is likely for dredged material in CDFs even when there is a demand for unprocessed dredged material for beneficial uses. In other cases, demand may be for certain product streams obtained from dredged material, such as sand, gravel, or fill materials, where the presence of debris and trash would interfere with the processing equipment or the acceptability of the final product. Prior to beneficial use, contaminated dredged material in CDFs will have to undergo processing to remove or reduce the concentration of contaminants. Debris and trash mixed with dredged material would interfere with remediation processes and would have to be removed. Debris and trash are not inherently toxic as they consist of both natural materials such as boulders, stones, and parts of trees, as well as anthropogenic (man-made) objects including metal, glass and plastic objects, discarded tires, used wood products including railroad ties, cable, wire, shopping carts, and concrete debris. Debris and trash removal is likely to be incorporated into both contaminated as well as uncontaminated dredged material processing.

DEBRIS FROM DREDGING: In the course of carrying out its mission of maintaining and improving navigation on 40,225 km (25,000 miles) of waterways that serve over 400 ports in the United States and enhancing the environment, the U.S. Army Corps of Engineers must manage over 300 million cubic meters of dredged material. The composition of the dredged material reflects the characteristics of the contributing watershed, the location of the site (rural, urban, industrial, coastal, or inland), the history of contaminated point and nonpoint sources of pollution in the watershed, and many other factors including previous dredging history and the type of dredging equipment employed.

In general, dredging has been conducted with mechanical dredges (bucket, which includes clamshell, orange-peel, and dragline, or dipper) or hydraulic dredges (plain suction, dustpan, cutterhead, hopper, and sidecast) (Headquarters, U.S. Army Corps of Engineers (HQUSACE), 1983; Hayes 1986; Havis 1986; U.S. Army Engineer Waterways Experiment Station 1998). Mechanical dredges are capable of removing and lifting relatively undisturbed loads of bottom materials, which may contain trash and large items of debris, while hydraulic dredges can transport nearly all items that are pumpable, including, for cutterhead dredges, pieces of cut rock (HQUSACE 1983). Thus, a rule of thumb is that a CDF that has been filled or partially filled from mechanical dredges is likely to have both debris and trash mixed with the dredged material; while a CDF that has been filled from hydraulic dredges is unlikely to have debris, but it is likely to have trash mixed with the dredged material. Hydraulic dredges carry out nearly 95 percent of the Nation's dredging, while most of the remainder is carried out by mechanical dredges (HQUSACE 1983).

The term debris as defined in this technical note refers to the following:

- Large items such as railroad ties.
- Demolition parts such as reinforced concrete.
- Tires.
- Boulders and stones.

The term trash describes smaller items (Figure 1) that find their way into dredged material:

- Plastic.
- Metal.
- Glass.
- Wood.

The composition of dredged material and its debris and trash content vary with the site from which it was dredged, the type of dredging equipment used, and the historical activities that impacted the watershed and environs of the dredged site. To reclaim useable material from contaminated dredged material in a CDF so that it can be applied to beneficial use, the debris and trash that may be with the dredged material must be separated from it. Separation of debris and trash from dredged material presents technical and economic problems because the separation process must take place at low cost. The Corps policy for dredged material from Federal navigation projects is for disposal to take place in the least costly, environmentally acceptable manner, consistent with sound engineering practices (Engler et al. 1988).

Most dredged material is uncontaminated (approximately 90 percent) (Winfield and Lee 1999)), although it may contain debris and trash. Naturally, there are fewer constraints on disposal sites for uncontaminated dredged material than there are for contaminated dredged material. Sometimes uncontaminated dredged material is disposed in CDF's when there is a high potential for material disposed in open water to wash back into a dredged channel or the transportation cost to an open-water disposal site is prohibitive. Contaminated dredged material may be disposed in open water with appropriate restrictions or, as is more often the case, disposed in CDFs. Because many existing CDFs are filled to capacity or are rapidly approaching that state, there is an increasing need to develop beneficial uses for both contaminated and uncontaminated dredged material in existing CDFs. These materials can then be removed and used, resulting in additional CDF storage capacity for future dredging activities.

a. Rock

b. Tire

c. Plastic pipe

d. Steel cable

e. Plastic bottle

Figure 1. Debris and trash found at CDFs

Winfield and Lee (1999) have enumerated potential beneficial uses of dredged material (Table 1). They note that reclaimed dredged material can be used in upland, wetland, or aquatic environments. They also note that waste materials that may not be present in a CDF, such as fly ash, alkaline wastes, and spent lime, may be added to dredged material that is initially unsuitable for beneficial uses to produce a product that has desirable and useful properties. Sewage sludge and yard waste have been blended with dredged material (Figure 2) to produce topsoil suitable for public uses including covering sanitary landfills. Debris and trash may be acceptable in a few of the potential beneficial uses of dredged material listed in Table 1, such as fill for washouts, solid structures for fish habitat, and the construction of islands. Otherwise, most of the potential beneficial uses of dredged material listed in Table 1 require material that does not contain debris and trash.

Table 1
Potential Beneficial Uses of Dredged Materials (from Winfield and Lee 1999)

Upland Environments
Fill, subgrade construction:
Highway/road/airport landing strip
Washouts/barren areas along highways
Mine shaft fill
Earthen slopes
Biomechanical erosion control structures
Cemeteries
Manufactured soil products:
Landscaping and bagged soil
Recreational areas/parks/campgrounds
Silviculture, horticulture, agriculture
Covers for landfills, Brownfield, Superfund and mining sites
Other manufactured products: asphalt, concrete, bricks
Wetland Environments
Constructed wetlands for water quality improvement
Creation of mitigation, wildlife habitat wetlands, marshes, etc.
Geotextile tube fill, berm construction
Biofilters for acid mine drainage and landfill leachate/seepage
Aquatic Environments
Capping open-water placement sites
Beach and shoreline nourishment
Solid structures for fish habitat
Geotextile tube fill
Creation of:
Islands
Tidal flats
Sea grass meadows
Oyster beds
Fishing reefs
Clam flats
Dike or berm construction
Construction material for port development

OVERVIEW OF CONCEPTS AND TECHNOLOGIES: Removal of debris and trash from dredged material in a CDF is tied closely to the process of reclaiming useable products, including soil. For this reason, the steps that are likely to be employed in reclamation of dredged material from a CDF are included in this discussion of debris and trash removal. Dredged material reclamation involves several steps, some of which are optional: land clearing and site preparation, preprocessing, mainstream processing, and postprocessing. The word stream refers to the flow of dredged material or products separated from it in the remediation, recycling, and reuse process, rather than to the flow in a waterway. Some of the major elements of these classifications of dredged material processing are discussed in the following paragraphs.

Land Clearing and Site Preparation. Land clearing and site preparation refer to the work that is carried out to make a suitable location for the dredged material remediation and reclamation equipment to be set up, provide roads and parking facilities, clear utility pathways, as well as clear the dredged material stockpile of its growth of trees and brush. The initial activities consist of clearing, grubbing, and stripping the land. Clearing, the complete removal of all above-ground matter that may interfere with subsequent operations, includes removal of standing and fallen trees,

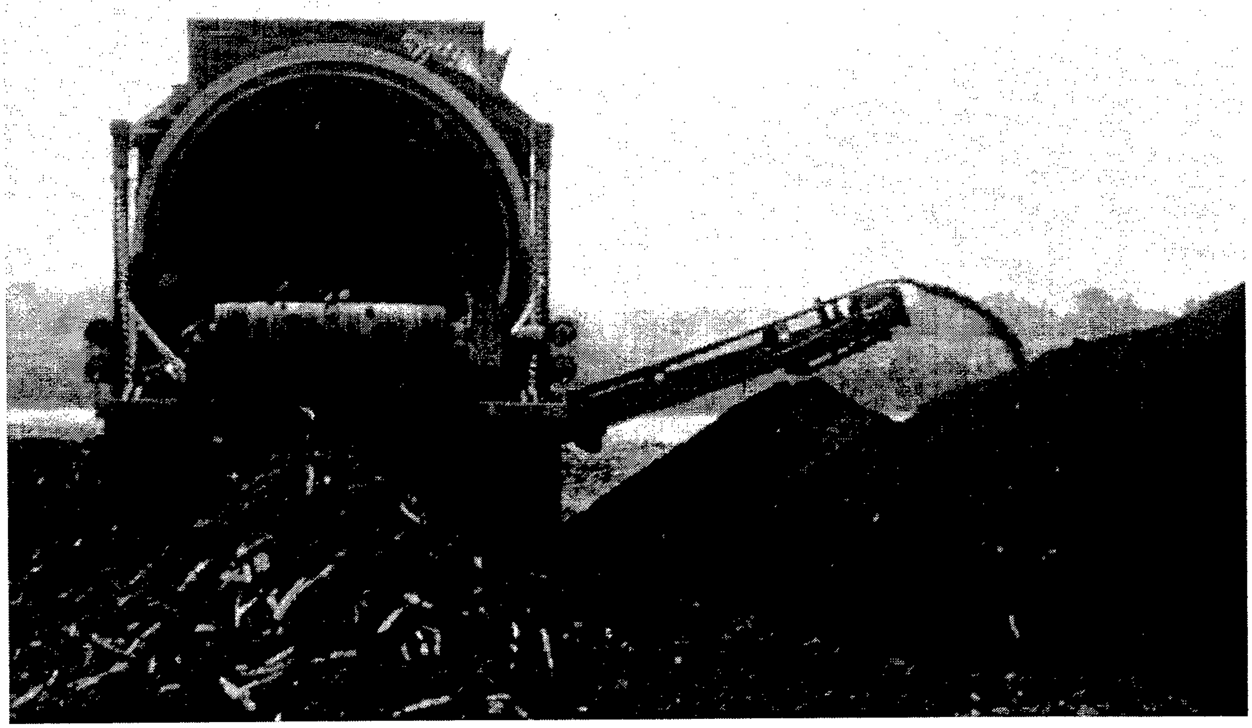

Figure 2. Portable truck-mounted trommel screen for removing extraneous plant rhizomes and clods (foreground) in manufactured topsoil (on right) from dredged material, yard waste, and biosolids at the Toledo, OH, CDF (photo courtesy of C. R. Lee, Environmental Laboratory, U.S. Army Engineer Research and Development Center)

brush, vegetation, and similar debris. Grubbing consists of the removal of below-ground matter that may interfere with subsequent operations, including stumps, roots, buried logs, and other objectionable material. Stripping consists of removal of low-growing vegetation and, in some cases, the organic topsoil layer (HQUSACE 1987). If trees are small, they may be cleared by wheeled tractors and bush hogs, if the dredged material is dry enough to provide traction. Otherwise crawler tractors and bulldozers may be required. Tree and brush disposal has to be considered. In some instances burning may be an option. Otherwise, trees and brush may be chipped to provide mulch or cellulose for manufacturing topsoil, hauled to other disposal sites, or left to decay.

Preprocessing. Preprocessing refers to the alteration of dredged material to prepare it for processing. When dredged material is hydraulically placed in a CDF, it is a high-water-content slurry. Mechanically rehandled dredged material placed in CDFs may also have a high water content that does not lend itself to some types of beneficial use. For example, if topsoil is to be reclaimed from fresh dredged material, dewatering will usually be necessary prior to addition of soil amendments. Generally, dredged material in a CDF has been at least partially dewatered. Therefore, preprocessing of dredged material in a mature CDF is less likely to involve accelerated dewatering and drying operations and is more likely to involve altering the physical structure of the dredged material to make it easier to run through processing equipment. For example, in some cases the dredged material may tend to form large clods and chunks of soil when tilled. In some of these situations, tilling in sand, vermiculite, lime, cellulose, and sewage sludge may improve the texture of the dredged material so that it can be processed more readily into recycled topsoil. In other

situations, mechanical dredging operations may have left an area of the CDF with a high concentration of concrete construction or other debris. In this situation, preprocessing may involve collection and removal of the debris so that a higher quality dredged material is left behind for processing. In summary, preprocessing of dredged material has to be evaluated on a case-by-case basis to decide what activities are appropriate.

Mainstream processing. Mainstream processing of dredged material is likely to consist of an equipment train that is assembled from several different individual items of processing equipment (the phrase equipment train is used in processing industries to refer to a sequence of mechanical components that are assembled together to accomplish some processing purpose). Refer to examples later in this technical note for information on proposed equipment trains and on operating experience on reclaiming soils from dredged material. Transportation costs to dispose of debris and trash removed during dredged material processing may become a significant cost item as disposal sites become farther from the processing site (Graalum, Randall, and Edge 1999; Arthur D. Little, Inc., 1998).

Postprocessing. Postprocessing refers to additional alterations that processed dredged material may receive. Postprocessing is likely to have as its objective the enhancement of certain characteristics of a recyclable product. For example, if gravel has been separated from dredged material as a distinct recyclable product, it may be washed to make it suitable for a user who intends to use it as a feed supply to an asphalt plant. By contrast, the gravel may not need to be washed if it is to be used for constructing walkways on all-weather paths in a park. Postprocessing may be appropriate to improve the physical characteristics of the material. For example, the material may have a high silt and clay content with the result that it is sticky and tends to dry into large, hard clods. If the potential market for the material is topsoil for use in new home landscaping, then postprocessing may consist of adding sand, lime, and organic matter (cellulose and biosolids) to improve the friability of the soil, making it easier for the landscaper and homeowner to till and plant. Even if the material is to be used as fill material to raise the elevation of depressions and low areas, some postprocessing may be justified. In examples presented later, portland cement has been added to a dredged material with a high silt and clay content to reduce the water content and to improve the structural strength of the fill. Bottom ash and fly ash have also been used to make dredged material suitable for landfill cover.

Market forces will influence the amount of postprocessing that is appropriate for a recycled dredged material. Naturally, if there is sufficient sustainable demand for the recyclable product without postprocessing, then it is questionable whether the cost of postprocessing is justifiable. For example, the U.S. Army Engineer District, St. Paul, covering the upper Mississippi River and its tributaries, has been able to apply approximately 70 percent of the annual production of dredged material to beneficial use as construction sand (U.S. Army Engineer District, St. Paul, 1996). Even though both mechanical and hydraulic dredges are used in the St. Paul District, debris and trash have not been a problem for dredged material reuse efforts. Sand is the major component of dredged material from the upper Mississippi River, and it is in demand for a variety of beneficial uses in the Minneapolis/St. Paul metropolitan area. Again, the decision on whether to engage in postprocessing will vary on a case-by-case evaluation of market forces and the supply and demand for the recyclable dredged material products.

EXAMPLES OF DEBRIS AND TRASH REMOVAL FROM DREDGED MATERIAL: Several examples have been selected to show how debris and trash can be removed when beneficial uses are planned for dredged material. The examples cover applications to dredged material in CDFs and freshly dredged sediment. Some of the examples focus on proposed processes that have not yet gained operating experience.

Example 1. *This example is extracted from a proposed process train that is not yet operating for recovering recyclable gravel and sand products from a CDF in Minnesota* (Wu 1999).

Actual operating experience on the proposed process train is not yet available. The proposed process train consists of the following pieces of equipment:

- Feeder with grizzly screen.
- Vibrator screen.
- Hydrocyclone.
- Screw classifier.
- Belt press and centrifugal dewatering equipment.
- Various conveyance devices.

These units in the process train, with the exception of belt press and centrifugal dewatering equipment, are identified in Figure 3, and their function is discussed in the following paragraphs.

Feeder with grizzly screen. Dredged material is dumped into the feeder, which has three walls to prevent the dredged material from spilling to the ground. The feeder provides some storage capacity, which helps to even out the flow of dredged material to the grizzly screen that is located at the bottom of the feeder. The feeder is open on one side to help the grizzly screen discharge large objects that are to be kept out of the remaining process train. The grizzly screen is a rugged piece of equipment that has heavy steel bars on its top side spaced a few inches apart, thus making up a bar rack to provide the screening action. The bars of the grizzly screen are sloped downward toward the open side of the feeder so that large debris can slide off the unit where they can be stored temporarily, then moved for further processing or placed in a disposal area. The bar rack in the grizzly screen has to be strong enough to support the weight of the dredged material feed as well as the shock of a load of dredged material being dumped into the feeder. The purpose of the grizzly screen is to reject oversized material including boulders, large stones, pieces of concrete, railroad ties, tires, larger pieces of scrap iron, large pieces of plastic, tree limbs, etc. The portion of the dredged material that is small enough to pass through the openings on the bar rack falls into a feeder bin that discharges to a conveyor belt, which carries the dredged material to the next item of processing equipment in the process train.

Vibrator screen. A double-decked screen is the next step in the process train. The vibrator screen produces three product streams. The top slotted screen is to remove gravel, so it has 25.4-mm (1-in.) openings. Small rocks and stones as well as some trash that passes the grizzly screen are rejected from the vibrator screen. The material that passes through the 25.4-mm (1-in.) openings next encounters a screen with 6.4-mm (0.25-in.) openings. Gravel is a product stream from the material

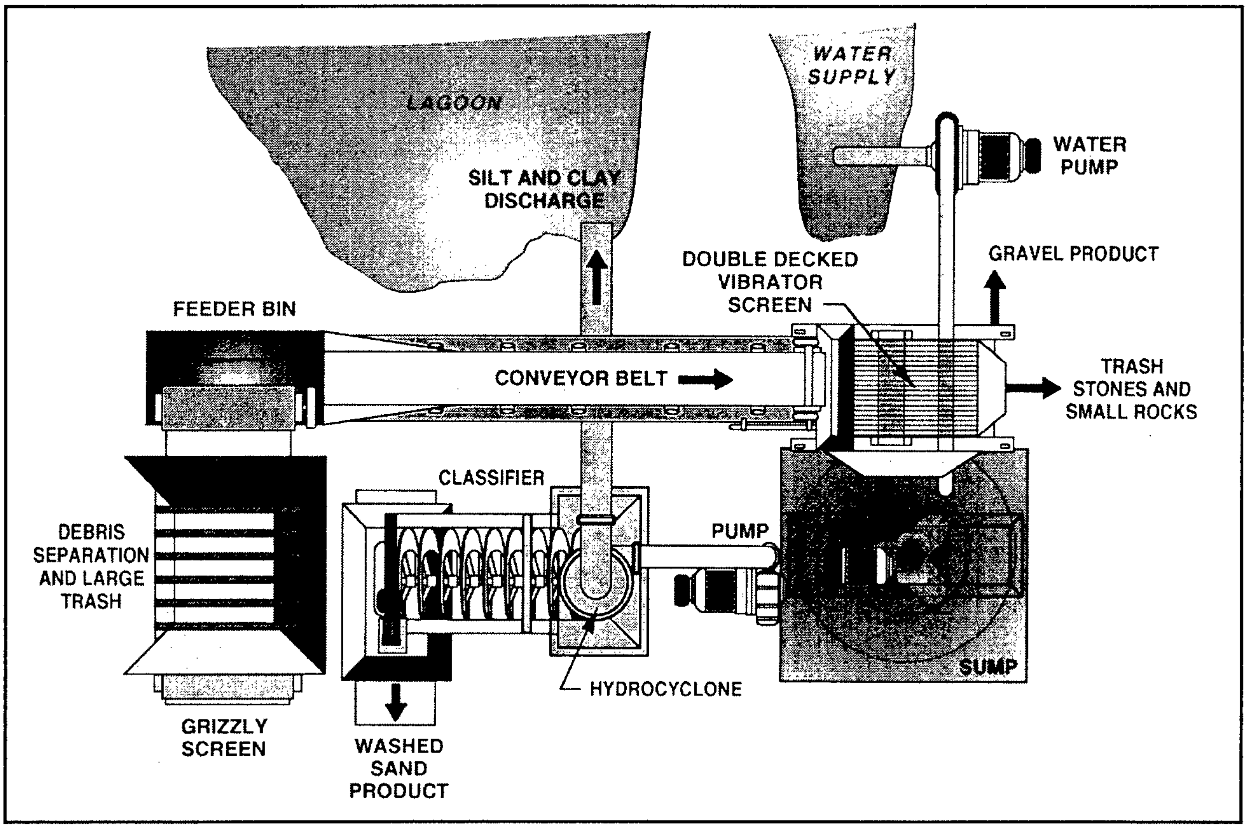

Figure 3. Proposed dredged material processing plan and equipment layout for recovering gravel and sand from the Duluth, MN, CDF

rejected from this screen. Coarse sand passes the screen, then it falls into a sump where it is mixed and pumped to the hydrocyclone. Water jet sprays are applied to both sides of each screen deck to increase the screen efficiency and to serve as makeup water for a sand slurry tank.

Hydrocyclone. The hydrocyclone separates silt and clay fractions from the sand. Sand is discharged from the underflow stream of the hydrocyclone, where it is conveyed to stockpiles, or it may be sent to the screw classifier for additional processing. The silt and clay fractions of the dredged material are conveyed from the overflow stream of the hydrocyclone and are discharged to a settling pond as shown in Figure 3, or they may be sent to a dewatering unit. Experience has shown that contaminants in dredged material tend to be associated with the silt and the clay fractions. This association is thought to be caused by contaminants preferentially adsorbing to the small particle-sized fractions. Thus, the silt and the clay fractions may be candidates for bioremediation if the site warrants it.

Screw classifier. The screw classifier helps to dewater and clean the coarse sand discharged from the hydrocyclone and removes some fines that are mixed with the coarse sand feed. The screw classifier produces a washed coarse sand product.

Example 2. *This example is developed from a pilot plant test by Dutch investigators of a proposed process that included separating debris and trash from dredged material* (de Kreuk, de Kreuk, and van Muijen 1998).

The Dutch pilot plant discussed in this example was tested to determine whether a pulsating bed separator could operate satisfactorily and at lower cost than a hydrocyclone to produce product streams from dredged material. The process was then scaled up into a proposed system that would produce several product streams from dredged material. The proposed process layout is shown in Figure 4. The key pieces of equipment are described in the following paragraphs.

Grizzly separator. A grizzly separator removes debris and trash that is larger than 100 mm in size.

Rotating screen scrubber. A rotating screen scrubber produces two product streams, one that has a size greater than 20 mm, and the other that is less than 20 mm in size. The material that is greater than 20 mm in size is expected to be useable without further processing. The fraction that is less than 20 mm in size undergoes further processing.

Vibrating screen. A vibrating screen separates the <20-mm material into two further fractions: one fraction is between 4 and 20 mm in size, and the second fraction is less than 4 mm in size and is sent to the pulsating bed separator where it is separated into two additional product streams.

Pulsating bed separator. A pulsating bed separator is fed with the <4-mm stream from the vibrating screen. The pulsating bed separator separates this material in two ways, by density and by size. In this way, organic material may be separated from mineral material that has a similar size. The lighter material is sent to a sedimentation basin, while the mineral material is sent to a dewatering screen. Another alternative, for contaminated material, is to send the contaminated organic material to a bioremediation treatment process.

Dewatering screen. A dewatering screen separates the mineral matter from water, producing a product stream that is ready for use.

Sedimentation basin. A sedimentation basin separates the fine organic material and some fine mineral matter from water. There was no discussion about the use of chemical or polymer coagulants and flocculants to aid in the sedimentation process.

The Dutch authors emphasized in their discussion of the pulsating bed separation process that it may have some advantages over the hydrocyclone. One of the advantages was that it was expected to consume less energy to operate. Another advantage was that it was expected to require less water. The authors also pointed out that it may have advantages over a hydrocyclone in separating out contaminated sediments, as these sediments are expected to be concentrated into the fine material.

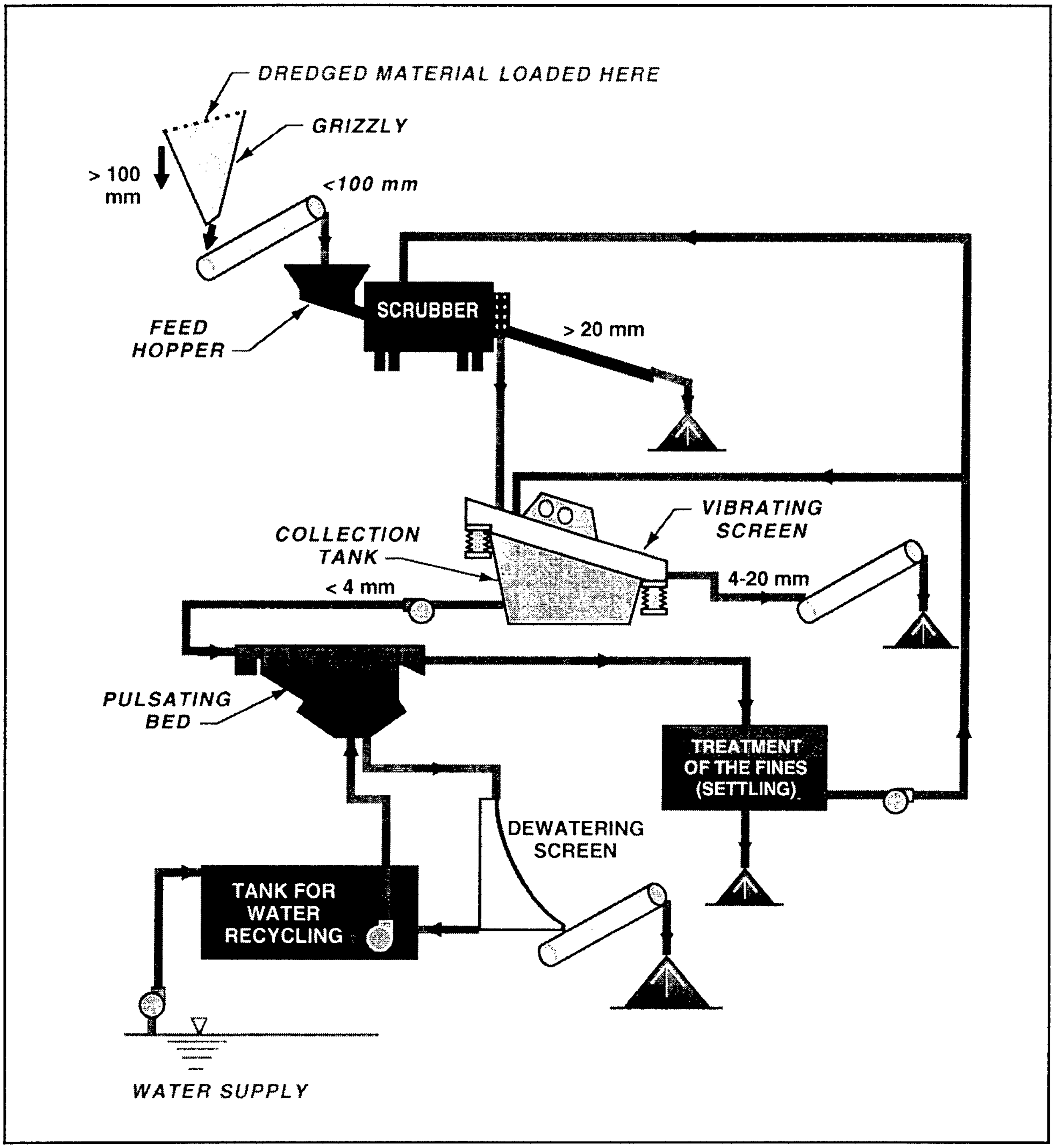

Figure 4. Dredged material processing plan and equipment layout for separating debris and trash from dredged material (adapted from de Kreuk, de Kreuk, and van Muijen 1998)

Example 3. *This example is developed from information on beneficial use of freshly dredged sediment from the New York and New Jersey area. Three cases are presented for which there is operating experience for beneficial uses of processed dredged material: one of the cases discusses use of dredged material for strip-mine reclamation in Pennsylvania, and two of the cases discuss use of dredged material for construction fill.*

Construction and Marine Equipment Company Site. Dredged material was processed prior to being sent by rail cars to Pennsylvania for use in strip-mine reclamation (Appendix I). Mechanically dredged sediment from the municipal marina in Perth Amboy, NJ, was offloaded with a bucket dredge at a dock, passed through a grizzly to remove debris (Figure 5), then mixed with coal fly ash in a pug mill. Pug mills are easily disabled by debris, and as Figure 5 shows, tires, timbers, and some other large pieces of debris were removed by the grizzly.

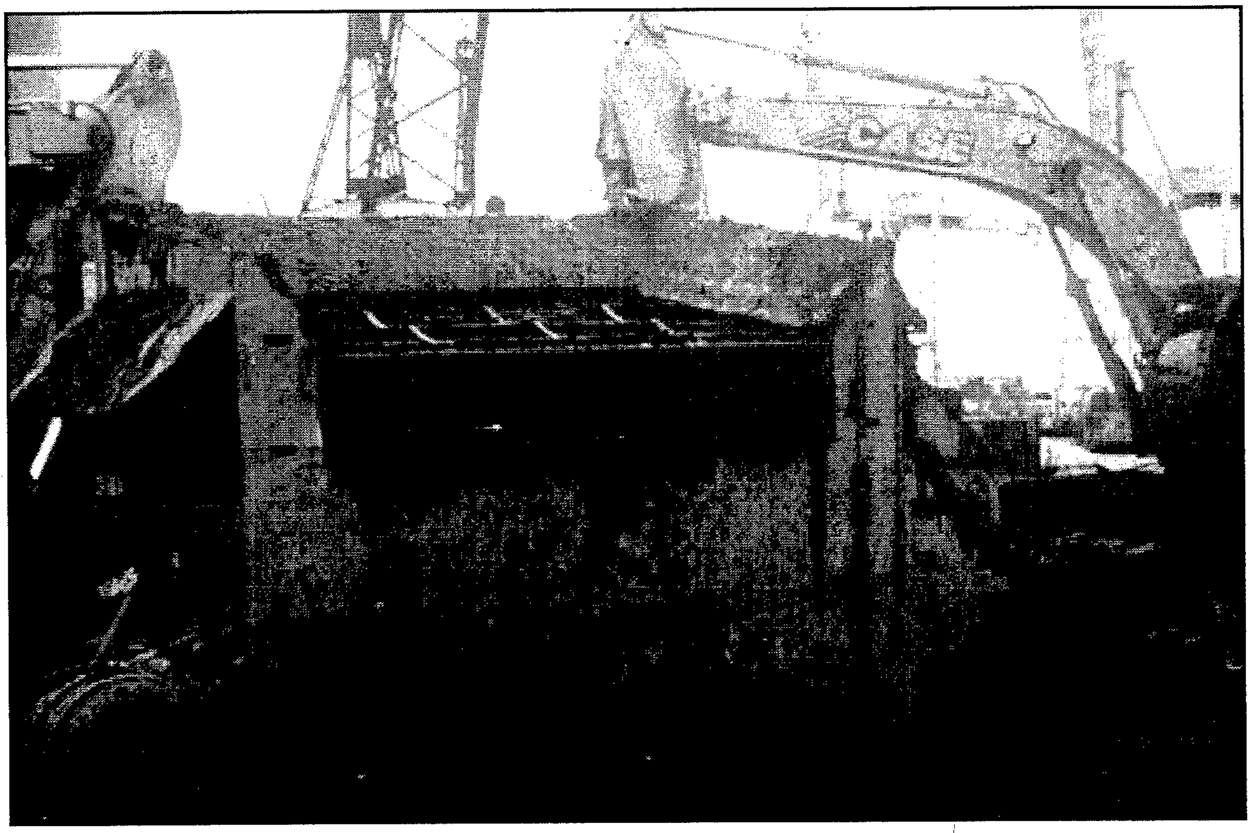

Figure 5. Grizzly at Construction and Marine Equipment Company site

Jersey Gardens Mall Site, Elizabeth, NJ. Dredged material was used as fill material to construct approximately 526,000 m^2 (130 acres) of parking lots at a shopping mall in New Jersey (Oweis 1999; Appendix I). Fresh dredged sediment was mixed with portland cement and used for structural fill under parking lots to raise the elevation above the 100-year floodplain. Sediment was mechanically dredged from various sites, barged to an off-loading facility adjacent to the mall site, mixed with portland cement (8 percent by weight) in a pug mill, and trucked to the construction site. Initially, dredged material was offloaded from the barges hydraulically, but debris and trash clogged the pumps. Eventually, pipeline transport of the dredged material was abandoned.

Problems with trash and debris resulted in a redesign of the transportation system for getting dredged material from the barges to the pug mill. Debris and trash were also a problem at the pug mill and had to be removed prior to processing.

Port Newark, Seaboard Site. Dredged material from the Arthur Kill Federal Navigation Channel and from Port Newark was used as fill material at the Seaboard site after portland cement was mixed with the dredged material (Appendix I). Mechanically dredged sediment was placed in scows and transported to a dockside processing facility in Port Newark. The processing facility consisted of silos for storage of portland cement, a conveyor for transfer of portland cement to the scows, and a backhoe equipped with a rotary mixer (Figure 6).

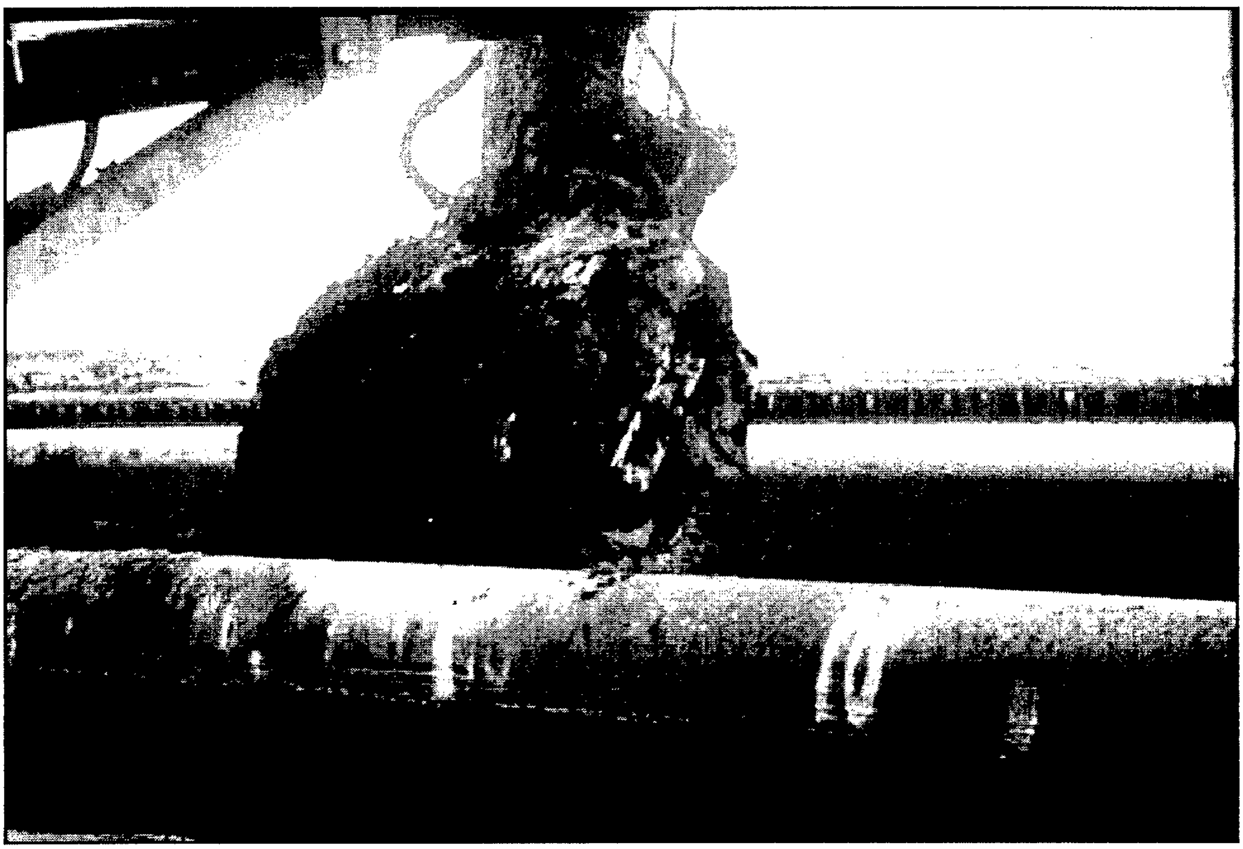

Figure 6. Backhoe-mounted rotary mixer

Debris and some trash were removed prior to the addition of portland cement by drawing a rake attached to a backhoe through the dredged material while it was still in the scows. Portland cement was mixed (8 to 12 percent by weight) with the dredged material in the scows by a backhoe-driven rotary mixer at dockside. The scows were then moved to the Seaboard site and the processed dredged material was used as fill material. Site use is expected to be light industry and warehouses. The backhoe-mounted rotary mixer used in this project was not as sensitive as a pug mill to debris and trash, although large items, such as tree trunks, railroad crossties, etc., still had to be removed.

SUMMARY: The life of a CDF can be extended by removing dredged material for application to beneficial uses. The composition of dredged sediments in CDFs reflects several factors, including the watershed in which dredging takes place, local land use activities, and method of disposal with mechanical or hydraulic dredges. Mechanical dredges pick up relatively undisturbed loads of sediment that can include debris, while trash may be present in both mechanically and hydraulically dredged sediments. Debris and trash are not inherently toxic, although their removal raises the cost of processing dredged material for beneficial use. A grizzly unit is commonly used at the beginning of an equipment processing train to separate debris and some trash, although one of the examples discussed using a rake in a scow for this purpose. The remaining pieces of equipment in the processing train depend on the composition of the dredged material, its beneficial uses, and the presence of contaminants that may require remediation. Examples are presented showing sand and gravel reclamation, topsoil production, and fill development from processed silt and clay material. Silt and clay dredged material can even be processed with additives to form a product used for strip-mine reclamation. Although cost information is scanty for dredged material applied to the types of beneficial uses described in this technical note, some estimates are $13 to $20 per cubic yard for processed topsoil (Graalum, Randall, and Edge 1999); $47 to $48 per cubic yard for amendment with portland cement and use as construction fill; and $59 per cubic yard for amendment with fly ash and use in strip-mine reclamation. Economies of scale and cost reduction as operating experience is developed should reduce costs.

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> Myers, T. E., and Adrian, D. D. (2000). "Equipment and processes for removing debris and trash from dredged material," *DOER Technical Notes Collection* (ERDC TN-DOER-C17), U.S. Army Engineer Research and Development Center, Vicksburg, MS. *www.wes.army.mil/el/dots/doer*

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APPENDIX I

TRIP REPORT; BROWNFIELDS AND STRIP-MINE RECLAMATION USING NY/NJ DREDGED MATERIAL

CEWES-EE-R 31 August 1998

MEMORANDUM FOR RECORD

SUBJECT: Trip Report - Brownfields and Strip-Mine Reclamation Using NY/NJ Dredged Material

1. On 8 July 1998, Danny Averett and I visited three innovative dredged material beneficial use projects in the New York/New Jersey area. Mr. Kerwin Donato, CENAN-PL-ES, made arrangements for the site visits and accompanied us to the sites in a Government vehicle. Two projects involved Brownfields redevelopment, and one involved processing dredged material for rail shipment to a strip mine reclamation study site.

2. Jersey Gardens Mall Site, Elizabeth, NJ. Our host at this site was Mr. Peter Aagaard, President, OENJ Corporation. The Jersey Gardens Mall site (formerly known as the Orion site) is an old sanitary landfill that is being redeveloped into a shopping mall - projected to be the third largest in New Jersey. The site is approximately 166 acres, total, with about 130 acres receiving dredged material processed by adding Portland cement for structural fill for a parking lot. Thickness of the dredged material fill will run 0 - 20 feet, and the site will be capped with clean fill before the final cover (asphalt) is placed. To date, 500,000 cu yds of dredged material have been used and another 100,000 cu yds will be needed to raise the site elevation above the 100-yr flood plain. Also, at the site is a demonstration of stabilized dredged material use as roadway embankment fill. CENJ plans to have another Brownfields remediation project by the end of the year. It is called the Bayonne/PSE&G site in Bayonne, NJ. If developed as planned, this site will accept 4 MCY of dredged material. The end use for the Bayonne/PSE&G site will be recreational facilities, including a golf course.

3. Sediment is mechanically dredged from various dredging sites including the Port of Newark and Liberty Island (no Corps projects) and barged to an off-loading facility adjacent to the Jersey Gardens Mall site (SeaLand terminal). Portland cement (8 percent by wt) is blended with dredged material in a pug mill, and the Portland cement/dredged material mix is trucked to the

construction site. Different formulations of lime, kiln dust, and fly ash have been used in the past as substitutes for Portland cement, but Portland cement continues to be preferred. The pug mill was not operating, and we did not get to see it. Debris removal was not discussed, but Mr. Aagaard indicated that pipeline transport of dredged material to the pug mill was not successful because debris caused problems with the pumps. At the construction site, processed dredged material is roller compacted in 1 foot lifts. In selected areas where additional strength is needed, the material is dynamically compacted with a 16-ton load dropped from a crane after roller compaction. The purpose of compaction is to meet density requirements for construction fill. Density is monitored in the field with a nuclear densiometer. Compaction takes about a week, depending on weather conditions. About 6000 cu yds can be processed in a day. Current costs are $45 - $48 per cu yd, including dredging, transport, treatment, and placement.

4. Port Newark/Seaboard Site. Our hosts were Eric Norton and Craig Edwards, Laidlow Environmental (ECDC subcontractor). Mr. Norton gave us a tour of the dredged material processing facilities at Port Newark, Newark, NJ, and Mr. Edwards gave us a tour of the Seaboard site. Sediment from the Arthur Kill Federal navigation channel is mechanically dredged, placed in scows, and transported to a dock-side processing facility at Port Newark. ECDC was awarded two Corps contracts at bid prices of $48/cy for 390,000 cu yds from Newark Bay channels and $47/cy for 913,000 cu yds from Arthur Kill Channel and 300,000 cu yds from Port Newark. The processing facility consists of silos for storage of Portland cement, a conveyor for transfer of Portland cement to the scows, and a back-hoe equipped with a rotary mixer. Debris is removed before Portland cement addition using a rake attached to a back-hoe. Portland cement is mixed (8 - 12 percent by wt) with dredged material in the scows by a back-hoe driven rotary mixer at dock-side. After mixing, the scows are moved to the Seaboard site where the Portland cement-dredged material mix is cured for 24 hours in the scow before off-loading. The processing facility processes 6,000 to 12,000 cu yds per day. Since January 1998, 800,000 cu yds have been processed and barged to the Seaboard site.

5. The Seaboard site is a vacant 160-acre Brownfield situated along the Hackensack River in Kearny, NJ. The site was developed in 1917 as a coal-tar products facility (Koppers Coke) built on fill material (miscellaneous urban waste). Dredged material is off-loaded with a bucket dredge and placed in 20-yd dump trucks. For the past several months, processed material has been stockpiled on 25 acres called the interim storage site, until the

rest of the site is permitted for placement. At the time of our visit, the stockpile was 40 feet high. We actually drove up on the stockpile in an ECDC pickup. Material from the stockpile is now being reloaded into dump trucks and placed in the area requiring fill. Material is spread, disked, compacted with a sheep's-foot roller and then a drum roller, and graded. After processing with Portland cement and compaction, there is a 20 to 25 percent shrinkage factor. Spreading and compacting material directly from the barge is currently being tested at the site. Processed dredged material is being used to raise the site elevation above the 100-yr flood plain. Site end use will probably be light industry, warehouses and the like. The site has the capacity to accept 4.5 M cu yds of processed dredged material, and it is anticipated that it will take another 4 years to complete the project. Eventually a slurry and sheetpile wall will be constructed to cut off leachate flow to the Hackensack River from the coke plant residuals that remain in the foundation soils.

6. Construction & Marine Equipment Company Site. Construction & Marine Equipment Company is located in Elizabeth, NJ. A city street splits the property with a marine dock, fabrication facilities, and offices for company operations on one side of the property and a rail spur on the other side of the property. Mechanically dredged sediment from the municipal marina in Perth Amboy, NJ is off-loaded with a bucket dredge at the dock, passed through a grizzly to remove debris, and then mixed with coal fly ash in a pug mill. Processed material is trucked across the street to the rail yard. In the rail yard, the material is loaded into rail cars with a front-end loader. The material is taken to the Bark Camp Mine Reclamation Laboratory in Houston Township, PA where additional coal fly ash is added prior to placement. Lime kiln dust and quicklime may also be added. The Bark Camp Mine Reclamation Laboratory is conducting studies on a variety of strip-mine reclamation technologies. We did not visit the Bark Camp Mine Reclamation Center. The Construction & Marine equipment Company project will process and transport approximately 23,000 cu yds of dredged material. The company is gearing up for another dredging project involving 20,000 cu yds from a municipal marina in Belmar, NJ for placement at Bark Camp. Costs for both projects are $59/cy, exclusive of dredging. Costs (exclusive of dredging) are being borne by the office of New Jersey Maritime Resources. It is hoped that costs will drop to the $20 to $40/cy range for long-term, large-scale mine reclamation projects in Pennsylvania.

7. Summary. Large-scale beneficial use of processed dredged material as construction fill is being successfully demonstrated

at two sites, and the potential for using processed dredged material in strip mine reclamation is being investigated in another demonstration project. Different formulations of various binders have been used, including Portland cement, cement kiln dust, lime kiln dust, quicklime, and coal fly ash. The primary purpose of the binders is to react with water, and thereby dewater the dredged material and create a soil like material. Debris removal is a necessary step before dredged material can be effectively blended with binders. Processing costs are significantly affected by binder costs. Key factors affecting the success of these waterfront Brownfields reclamation/dredged material projects are a) a critical need for innovative dredged material disposal options, b) aggressive pursuit of innovative dredged material disposal options by local and state government, c) the high cost of transporting conventional fill material in highly congested areas, d) availability of marine terminals and channels for barging in dredged material, and d) availability of waterfront Brownfields for redevelopment. The New York District has played and is continuing to play a major role developing innovative dredged material beneficial uses, such as the projects described in this memorandum.

8. Photos from the trip follow the distribution list.

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Figure A1. Freshly placed, Portland cement processed material at the Jersey Gardens Mall Site, Elizabeth, NJ

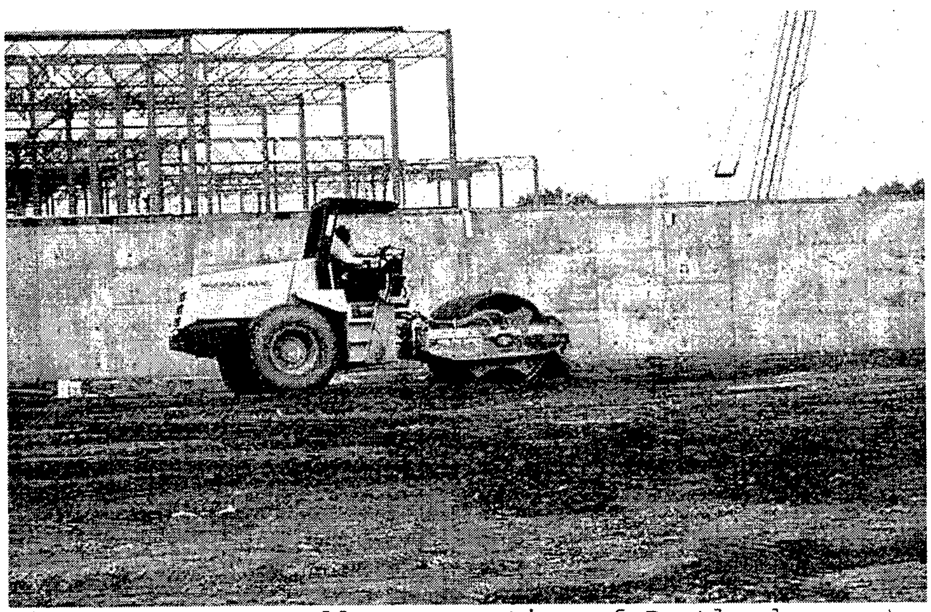

Figure A2. Drum roller compaction of Portland cement processed material at the Jersey Gardens Mall site

Figure A3. Dynamic compaction of Portland cement processed material at the Jersey Gardens Mall Site

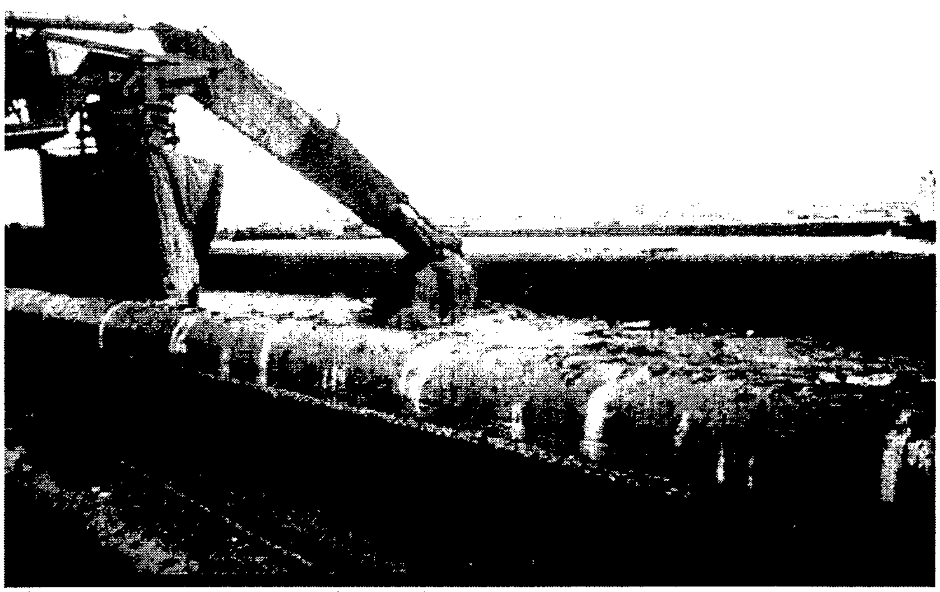

Figure A4. Rotary mixer in scow at Port Newark, Newark, NJ

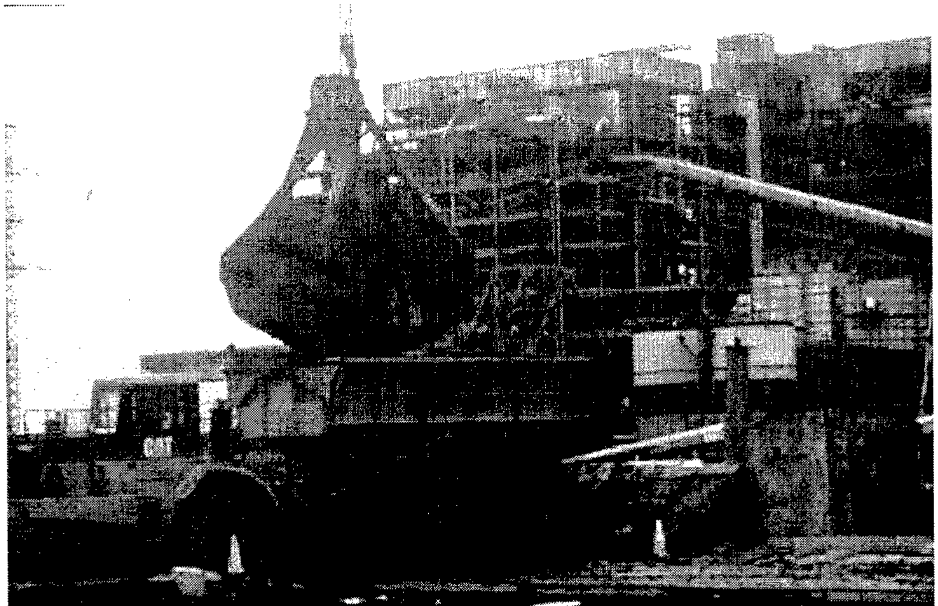

Figure A5. Transfer of processed material from scow to dump truck at Seaboard site

Figure A6. Stockpile of Portland cement processed material at Seaboard site

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